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Automobile Vibration and their Control

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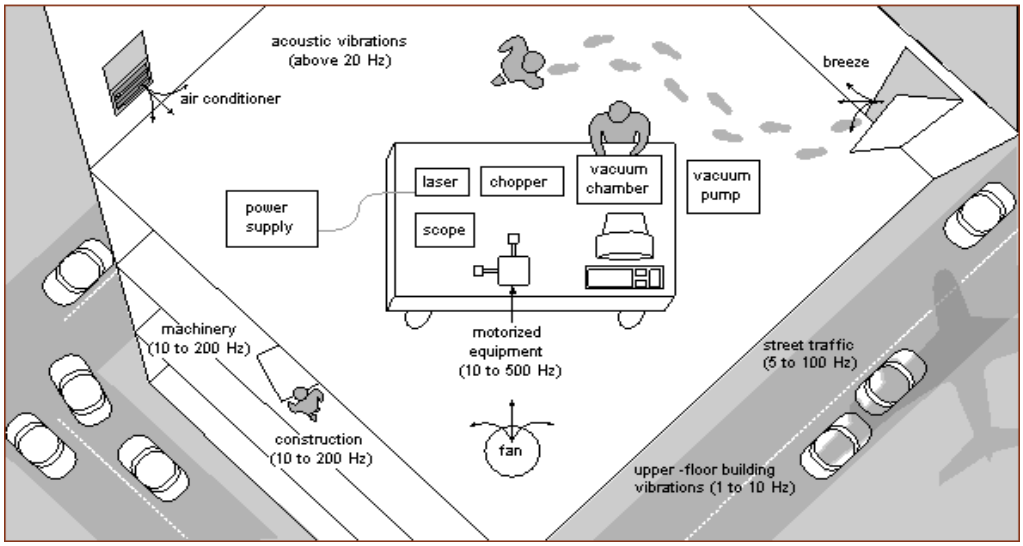
Abstract— *The vibration is harmful noise for every moving machine. This paper describes vibration general sources. The paper also describes automobile vibration and their elimination. As researches found the frequencies of different domestics vibration sources is varies between 4 Hz to 220 Hz and in automobile it nearly about 30 Hz. This paper also describes the vibration absorbers for automobile application.*

Keywords—Noise, Vibration Sources, automobile, Vibration Absorber.

I. INTRODUCTION

Vibration, means oscillation which generates noise, it has three main categories: seismic vibrations, acoustic vibrations and, free and forces vibration [1].



Periodic vibration comes through continuously running vibration system. Random vibrations generates through from unpredictable sources like car component vibrations [3]. The frequency range has been found from 4-400 Hz of most of vibrations for various applications and also mentioned in below Table I and II [4].

TABLE I. VIBRATION SOURCES AND THEIR FREQUENCIES

Type	**Frequency(Hz)**	**Amplitude**
Air Compressors	4 – 20	10^{-2} in
Handling Equipment	5 – 40	10^{-3} in
Pumps (Vacuum, comp or non-comp fluids)	5 – 25	10^{-3} in
Building Services	7 – 40	10^{-4} in
Foot Traffic	0.5 – 6	10^{-5} in
Acoustics (B)	100 – 10000	10^{-2} to 10^{-4} in
Air currents	Labs can vary depending on class	Not applicable
Punch Presses	Up to 20	10^{-2} to 10^{-5} in
Transformers	50 – 400	10^{-4} to 10^{-5} in
Elevators	Up to 40	10^{-3} to 10^{-5} in
Building Motion	46/Height in meters,	0.1 in

Vibrations sources are bottom traffic, wind blowing the structure, vehicular traffic, and construction aeration fans etc. the lots of the seismic vibration sources that generate also generate acoustic vibrations. The effects of air pressure measure through it [2]. The forces functional straightforwardly to the load on the functioning outside; they are directly coupled mechanically to the tentative setup.

II. IDENTIFICATION OF VIBRATION SOURCES

Vibrations are either random or periodic, in around environment vibration sources shows in figure 1.

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	Horizontal	
Building Pressure Waves	1 – 5	10^{-5} in
Railroad	5 - 20	±0.15g
Highway Traffic	5 - 100	±0.001g

TABLE II. VIBRATION SOURCES AND THEIR FREQUENCIES

Vibration source	**Acceleration (m/s2)**	**Frequency (Hz)**
Drilling machine	0.93	178
Lathe machine	1.36	68
Bearing test bed	10.57	200
Refrigerator	0.14	110
Washing machine	0.82	62
Cloth dryer	4.21	59
Microwave oven	0.49	40
A/C compressor	2.14	59
Car engine	0.56	30
Truck engine	1.98	37

III. AUTOMOBILE VIBRATIONS AND THEIR CHARACTERISTICS

There are two major reasons for generation of car vibration like, first reason Engine vibration and Second if an axle gets bent. Other reasons like Brake Trouble, Wobbly Wheels, and Tire Problems etc.

The automobile vibrations are classified according to when they occur[6] as shown in figure 2:

(1) Vehicle speed sensitive – This noise direct proportion to vehicle speed and only occurs at certain speeds.

(2) Acceleration/deceleration sensitive -- This noise depends on change in vehicle speed.

(3) Engine speed sensitive -- This vibration is generates through engine speed. The vibration is also direct proportion to engine rpm [7].

(4) Suspension Vibration - It occurs when suspension has problem in the driveline or chassis.

(5) Speed Sensitive Vibrations: At speeds above 45 to 50 mph most of wheel facing imbalance problems that are causes of speed sensitive vibration. A back-and-forth shimmy wheels are dynamically imbalanced. Whereas a sawtooth design wheels are also produce vibrations and also speed sensitive [8].

(6) Driveshaft Vibrations: That's reason also produce vibration.

(7) Resonance: It generally produced by exhaust system.

(8) Broken engine mountings: Engine mounting materials are hard rubber-like objects which hold and fix whole engine at their position and also preventing metals rubbing to each other. The vibration generates when mounting broken.

(9) Random – This vibration comes through random sources of Car body and also comes through road. They generates through loose shock absorbers, ball joints, spring mounts, stabilizer bars, control arm bushings, etc. Loose/broken ball joints and Brakes: These are loose or broken that generates vibrations [9].

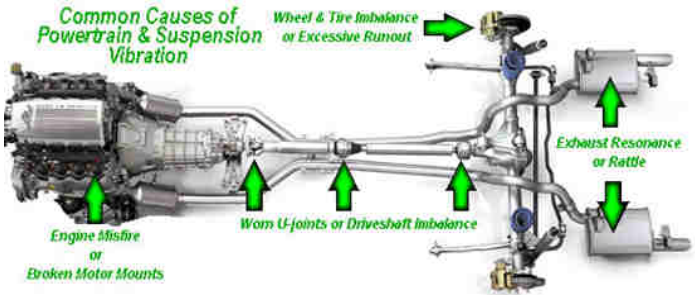

Fig.2: Automobile vibration

Automobile vibrations and sources are shown in Table III.

TABLE III. CAR VIBRATION DATA (1000CC)

Vibration location	**Acceleration (m/s^2)**	**Frequency (Hz)**	**Amplitude (µm)**
Engine	1.23	30.5	33.5
Radiator	0.16	29.5	4.66
Headlight	0.23	29.5	6.64
Bonnet	0.18	29.5	5.18
Dashboard	0.04	30	1.07
Roof	0.26	29.5	7.54

IV. MOUNTING SYSTEM

The vibration frequency range is varies from 4Hz to 100 Hz, it is necessary to make an isolation system that can attenuate all dynamic vibration inputs [10]. There are two factors to be considered before making a isolation system:

•The severity of the environment - it's the primary factor for determining the level of isolation which is required.

•The sensitivity of the application -it's also the primary factor for determining the stiffness and internal damping features.

The mountings absorbs/reduces/cancels the vibrations produced by vehicles or their components. There is some impotence of anti vibration mountings like Noise of the running engine is attenuated, which helps for smooth working. And improve the all over functionality of vehicle. The some harmful noise generates when engine runs that is known as annoying noise, the isolators can used to minimize this potentially noise [11].

It is necessary to consider high vertical stationary & shock load in compression when anti vibration system going to design. The design may be combination of sheet metal components, ferrous or non-ferrous castings with

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nuts, bolts, etc. The heavy load or metallic part should be mounting on high grade cushion like neoprene rubber and low carbon steel should use for rusting. It is also necessary to fitted at specific location to optimal vibration isolation.

There are some selection criteria for selection perfect anti vibration mountings like first it observe the material which used, Load bearing capacity of the mountings, shock absorption and deflection characteristics of the mountings.

The deadly accident will occurs when no mounting of engine. The engine mounts basically consists two steel plates with tightly sealed in engine body that easily absorbs the vibrations. The thick rubber cushion is applied in between the two steel plates that absorb most of the vibrations from the engine. In other word engine mounts also the backbone of automobile, it has lot of advantages like it ensure stable running of engine, Provides high isolation value in the horizontal shear direction, protects other components of vehicle from vibrations etc. There are some mountings explained in next and shown in figure 3.

(a) Cushion Mountings: This usually used for diesel gen sets, Compressors, Cooling Systems hydraulic systems and pumps. The cushion foot mounting is high performing anti-vibration mountings that can be easily installed on various machines and also use as friction pads are in combinations in the mounts. Special quality rubber is used as raw material like Natural Rubber, SBR, EPDM, Neoprene, Silicone etc..

The Absorb shock, Isolate vibrations and noise reduction are the main function of cushion mounting. They are available in several of dimension with high resistance for surface abrasion, operating condition and with chemicals. They have highly dynamic stiffness rate and easy to install and also have easy to maintains as shown in figure 3 (a).

(b) O Mounting: The O mountings are also eliminating vibrations produced by running engines. The cylinder shapes makes it a powerful shock absorber. The high grade steel is used for manufacturing of O mountings. It has cylindrical shaped with rubber affixed around it. The main purpose of this mounting in air conditioners, compressors, generator sets etc. The selection criteria same as of other mounting has.

(c) Rectangular Mounting: Rectangular mountings are type of rubber mountings. It is used for fixing engines. A Vehicle suspension springs and acoustic chambers are designed using rectangular mounting. The layered structure increase the load capacity of rectangular mounting. Most of these mountings are manufactured with fine quality metals preferably Steel and high grade rubbers are used to manufacture this. The result of apply this to performing at the optimum level, gives Longer life of equipment, Increased production capacity and Reduction in maintenance costs as shown in figure 3 (b).

(d) U Mountings: It is special kind of rubber mounting that having high shear strength. It absorbs shock resistance in lateral and vertical direction. This is used in electronics apparatuses, electrically controlled panels, suspending light components, and high speed motor resistance to grease, lubricants, surface abrasion wear, sunlight and UV rays etc as shown in figure 3 (b).

a) Cushion Mountings

b) Rectangular Mounting

c) U Mount

Fig.3: Different types of Automobile Mounting

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V. AUTOMOBILE INTELLEGENT ANTIVIBRATION SYSTEM

There are some major components are applied to absorb the vibration. In below figure 4 some major points show where absorber applied. Some of intelligent components that also generate vibration wave in anti-phase to other excitation with same amplitude that cancel generate vibration [12] as shown in figure 5.

(1) Backrest vibration absorber:

It is necessary to make contoured are easily and effectively accomplished. Most of people 50% suffer form of back pain and many of complaint related to poor seat design.

The main Purpose is to maintain for a stable posture muscles. Air spring system gives more comfortable design. The design is like scissors that control sleeve lever at 3 to 7 bar working pressure and also gives adjustable seat height. The air medium is optimized suspension and damping performance.

(2) Steering wheel vibration absorber:

The propeller shaft is way to transmitted vibration which generated by rear wheel drive to rear axle. The propeller shaft bearing stabilize the shaft in static for every dynamic operation and also control topple motion of shaft to minimize the vibration.

(3) Hydraulic absorbers:

The main work of hydraulic absorbers is to reduce structure-born vibration that generated by engine. The elastomer spring applied with hydro bushing that use for this work. Hydro bushings do isolation against vibration.

(4) Brake vibration absorbers:

The brake calipers and serves is used to reduce brake vibration and also reduce flexural vibrations.

(5) Active Absorbers:

The main purpose is to cancel out the vibration that generates through engine and other components. The general work to generate a anti signal of vibration that equal and opposite. It has mainly four components actuator, control unit, power amplifier and sensors. The sensors used for measure the vibration. This information gives to control unit that is generally electronic circuits, which gives signal to amplifier that generate opposite signal. This generated signal gives to actuator to generate opposite power and vibrate chassis. This process canceled the vibration.

(6) Internal tube vibration absorbers

In hollow drive shafts a internal tube is used, that pressed into shaft of a front wheel drive and reduce vibration.

(7) Torsional vibration absorbers

The engine's torsional vibration can be reduced by torsional vibration absorber. They are generally installed at the transmission outlet.

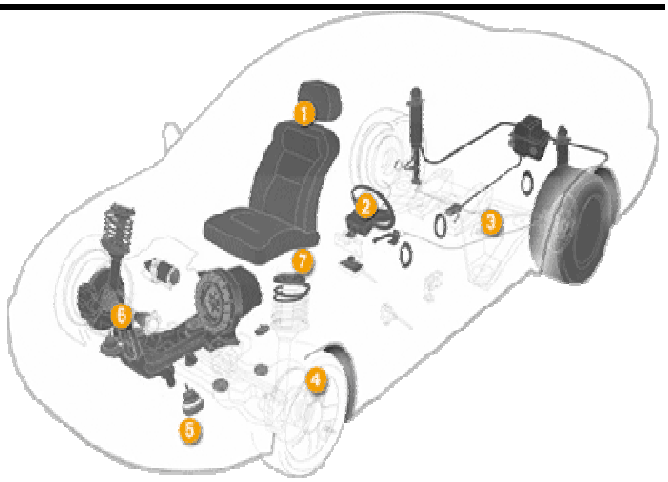
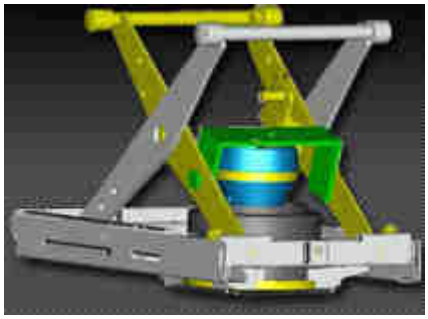


Fig.4: Intellegent Antivibration System



a) Backrest vibration absorber

b) Intermediate propeller shaft bearing

c) Hydraulic absorbers

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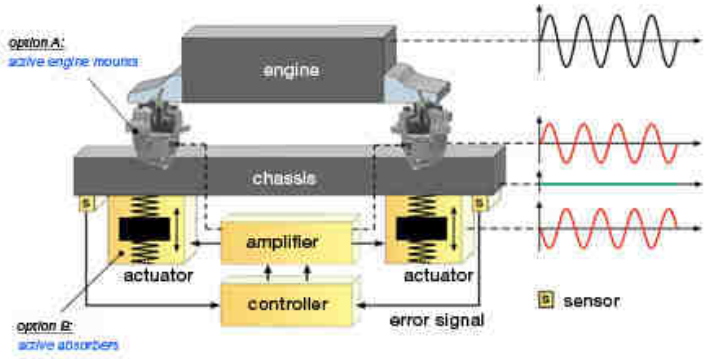
d) Car hydromounts

e) Commercial vehicle engine mount

f) Brake vibration absorber



g) Active Absorber

h) Internal tube vibration absorber

i) torsional vibration absorber

Fig.5: Components of Intellegent Antivibration System

VI. CONCLUSION

The paper explained the different types of vibration sources and their frequency in domestics. This paper also explained the vibration absorber / isolation system. In automobile intelligent anti vibration system explained for comfort driving

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